

What is claimed is:

1. A device interface apparatus having a physical layer, a link layer, a transport layer and an application layer, for transferring commands and data in packet format by serial transmission between a device and a host, the interface apparatus comprising:
 - a receive FIFO disposed at the transport layer and storing on a first-in first-out basis a command packet or a data packet received from the host via the physical layer and the link layer;
 - a command detection circuit detecting the command stored in the receive FIFO during data transfer and outputting a command detection signal;
 - a receive task file register disposed at the application layer and loading the command content of the receive FIFO;
 - a send task file register disposed at the application layer and loading a command or data for packet sending;
 - a send FIFO disposed at the transport layer and storing on a first-in first-out basis the content of the send task file register, the send FIFO causing a command packet or a data packet to be sent to the host via the link layer and the physical layer;
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an available time generation unit generating an available time for receiving another command packet from the host during data transfer; and
a mid-transfer command processing unit, when
5 a command packet is received from the host during the available time, suspending the data transfer to decode the received command for execution of processing and thereafter resuming the data transfer.

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2. The interface apparatus according to claim 1,
wherein

the mid-transfer command processing unit is
firmware implemented by execution of a program, and
15 wherein

the mid-transfer command processing unit
comprises:

a suspend processing unit, when the command
detection signal is output from the command
20 detection circuit for the command packet received
during the available time and stored in the receive
FIFO, suspending the currently executed data
transfer and saving parameters upon the suspension
into a memory;

25 a command decode unit decoding the command
content loaded from the receive FIFO into the
receive task file register;

a data transfer abort unit, when abortion of the data transfer is determined by the command decode unit, discarding the currently executed command and the saved parameters and terminating
5 the data transfer; and

a transfer resume unit, when continuance of the data transfer is determined by the command decode unit, throwing the command content of the receive task file register into a command queue, storing
10 command reception response information into the send FIFO and sending a command reception response packet to the host via the link layer and the physical layer, the transfer resume unit thereafter releasing the suspend of the data transfer and
15 setting the saved parameters to resume the data transfer.

3. The interface apparatus according to claim 1,
wherein

20 the available time generation unit detects completion of the transfer of the data packet sent to or received from the host to thereby set certain available time.

25 4. The interface apparatus according to claim 2,
wherein

the transfer resume unit rewrite s the data

stored in the second FIFO upon suspending of data transfer into response data to the received command for transfer of a command reception response packet, the transfer resume unit thereafter setting the 5 saved parameters to resume the data transfer.

5. A device interface apparatus for transferring commands and data in packet format by serial transmission between a device and a host, the 10 interface apparatus comprising:

a receive FIFO storing on a first-in first-out basis a command packet or a data packet received from the host;

15 a command detection circuit detecting the command stored in the receive FIFO during data transfer and outputting a command detection signal;

a receive task file register loading the command content of the receive FIFO;

20 a send task file register loading a command or data for packet sending;

a send FIFO storing on a first-in first-out basis the content of the send task file register and causing a command packet or a data packet to be sent to the host;

25 an available time generation unit generating an available time for receiving another command packet from the host during data transfer; and

a mid-transfer command processing unit, when a command packet is received from the host during the available time, suspending the data transfer to decode the received command for execution of processing and thereafter resuming the data transfer.

6. The interface apparatus according to claim 1, wherein

10 the mid-transfer command processing unit is firmware implemented by execution of a program, and wherein

the mid-transfer command processing unit comprises:

15 a suspend processing unit, when the command detection signal is output from the command detection circuit for the command packet received during the available time and stored in the receive FIFO, suspending the currently executed data
20 transfer and saving parameters upon the suspension into a memory;

a command decode unit decoding the command content loaded from the receive FIFO into the receive task file register;

25 a data transfer abort unit, when abortion of the data transfer is determined by the command decode unit, discarding the currently executed

command and the saved parameters and terminating
the data transfer; and

a transfer resume unit, when continuance of the
data transfer is determined by the command decode
5 unit, throwing the command content of the receive
task file register into a command queue, storing
command reception response information into the
send FIFO and sending a command reception response
packet to the host, the transfer resume unit
10 thereafter releasing the suspend of the data
transfer and setting the saved parameters to resume
the data transfer.

7. The interface apparatus according to claim 5,
15 wherein

the available time generation unit detects
completion of the transfer of the data packet sent
to or received from the host to thereby set certain
available time.

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8. The interface apparatus according to claim 6,
wherein

the transfer resume unit rewrites the data
stored in the send FIFO upon suspending of data
25 transfer into response data to the received command
for transfer of a command reception response packet,
the transfer resume unit thereafter setting the

saved parameters to resume the data transfer.

9. A packet transfer method for a device interface having a physical layer, a link layer, a transport layer and an application layer, the device interface transferring commands and data in packet format by serial transmission between a device and a host, the device interface including:

10 a receive FIFO disposed at the transport layer and storing on a first-in first-out basis a command packet or a data packet received from the host via the physical layer and the link layer;

15 a command detection circuit detecting the command stored in the receive FIFO during data transfer and outputting a command detection signal;

a receive task file register disposed at the application layer and loading the command content of the receive FIFO;

20 a send task file register disposed at the application layer and loading a command or data for packet sending; and

25 a send FIFO disposed at the transport layer and storing on a first-in first-out basis the content of the send task file register, the send FIFO causing a command packet or a data packet to be sent to the host via the link layer and the physical layer;

the packet transfer method comprising:
an available time generation step generating
an available time for receiving another command
packet from the host during data transfer; and
5 a mid-transfer command processing step, when
a command packet is received from the host during
the available time, suspending the data transfer
to decode the received command for execution of
processing and thereafter resuming the data
10 transfer.

10. The packet transfer method according to claim
9, wherein

the mid-transfer command processing step
15 comprises:

a suspend processing step, when the command
detection signal is output from the command
detection circuit for the command packet received
during the available time and stored in the receive
20 FIFO, suspending the currently executed data
transfer and saving parameters upon the suspension
into a memory;

a command decode step decoding the command
content loaded from the receive FIFO into the
25 receive task file register;

a data transfer abort step, when abortion of
the data transfer is determined by the command

decode step, discarding the currently executing command and the saved parameters and terminating the data transfer; and

5 a transfer resume step, when continuance of the data transfer is determined by the command decode step, throwing the command content of the receive task file register into a command queue, storing command reception response information into the send FIFO, sending a command reception response
10 packet to the host via the link layer and the physical layer, thereafter releasing the suspend of the data transfer and setting the saved parameters to resume the data transfer.

15 11. The packet transfer method according to claim 9, wherein

the available time generation step includes detecting completion of the transfer of the data packet sent to or received from the host and setting
20 certain available time.

12. The packet transfer method according to claim 10, wherein

the transfer resume step includes rewriting
25 the data stored in the send FIFO upon suspending of data transfer into response data to the received command for transfer of a command reception

response packet and ther after setting the saved parameters to resume the data transfer.

13. A packet transfer method for a device interface
5 transferring commands and data in packet format by serial transmission between a device and a host, the device interface including:

a receive FIFO storing on a first-in first-out basis a command packet or a data packet received
10 from the host;

a command detection circuit detecting the command stored in the receive FIFO during data transfer and outputting a command detection signal;

15 a receive task file register loading the command content of the receive FIFO;

a send task file register loading a command or data for packet sending; and

20 a send FIFO storing on a first-in first-out basis the content of the send task file register and causing a command packet or a data packet to be sent to the host;

the packet transfer method comprising:

an available time generation step generating an available time for receiving another command
25 packet from the host during data transfer; and

a mid-transfer command processing step, when a command packet is received from the host during

the available time, suspending the data transfer to decode the received command for execution of processing and thereafter resuming the data transfer.

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14. The packet transfer method according to claim 13, wherein

the mid-transfer command processing step comprises:

10 a suspend processing step, when the command detection signal is output from the command detection circuit for the command packet received during the available time and stored in the receive FIFO, suspending the currently executed data
15 transfer and saving parameters upon the suspension into a memory;

a command decode step decoding the command content loaded from the receive FIFO into the receive task file register;

20 a data transfer abort step, when abortion of the data transfer is determined by the command decode step, discarding the currently executed command and the saved parameters and terminating the data transfer; and

25 a transfer resume step, when continuance of the data transfer is determined by the command decode step, throwing the command content of the receive

task file register into a command queue, storing command reception response information into the send FIFO, sending a command reception response packet to the host, thereafter releasing the 5 suspend of the data transfer and setting the saved parameters to resume the data transfer.

15. The packet transfer method according to claim 13, wherein

10 the available time generation step includes detecting completion of the transfer of the data packet sent to or received from the host and setting certain available time.

15 16. The packet transfer method according to claim 14, wherein

the transfer resume step includes rewriting the data stored in the send FIFO upon suspending of data transfer into response data to the received 20 command for transfer of a command reception response packet, and thereafter setting the saved parameters to resume the data transfer.

17. A device interface apparatus having a physical 25 layer, a link layer, a transport layer and an application layer, for transferring commands and data in pack t format by serial transmission

b tween a device and a host, the interfac apparatus comprising:

5 a receive FIFO disposed at the transport layer and storing on a first-in first-out basis a command packet or a data packet received from the host via the physical layer and the link layer;

a receive task file register disposed at the application layer and loading the command content of the receive FIFO;

10 a send task file register disposed at the application layer and loading a command or data for packet sending;

15 a send FIFO disposed at the transport layer and storing on a first-in first-out basis the content of the send task file register, the send FIFO causing a command packet or a data packet to be sent to the host via the link layer and the physical layer;

20 an I/O control unit inputting and outputting data such that predefined one unit of data stays in the send FIFO at all times, the I/O control unit outputting a head signal in synchronism with input and output of headmost data of the packet and outputting a tail signal in synchronism with input and output of endmost data of the packet; and

25 an error-terminated transfer control unit, when data input is halted by an error during data

transmission, outputting to the link layer th one unit of data staying in the send FIFO together with the tail signal and causing a data packet to be transferred to the host.

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18. The interface apparatus according to claim 17, wherein

the I/O control unit when received data is stored into the send FIFO, stores the received data
10 after outputting the previously received data.

19. The interface apparatus according to claim 17, wherein

the I/O control unit forces the minimum unit
15 of data to stay as one unit of data in the send FIFO.

20. A packet transfer method for a device interface having a physical layer, a link layer, a transport layer and an application layer, the device
20 interface transferring commands and data in packet format by serial transmission between a device and a host, the device interface including:

a receive FIFO disposed at the transport layer and storing on a first-in first-out basis a command
25 packet or a data packet received from the host via the physical layer and the link layer;

a receive task file register dispos d at the

application layer and loading the command content of the receive FIFO;

5 a send task file register disposed at the application layer and loading a command or data for packet sending; and

10 a send FIFO disposed at the transport layer and storing on a first-in first-out basis the content of the send task file register, the send FIFO causing a command packet or a data packet to be sent to the host via the link layer and the physical layer;

15 the packet transfer method comprising:

20 an I/O control step inputting and outputting data such that predefined one unit of data stays in the send FIFO at all times, the I/O control step outputting a head signal in synchronism with input and output of headmost data of the packet and outputting a tail signal in synchronism with input and output of endmost data of the packet; and

25 an error-terminated transfer control step, when data input is halted by an error during data transmission, outputting to the link layer the one unit of data staying in the send FIFO together with the tail signal and causing a data packet to be transferred to the host.

21. The packet transfer method according to claim

20, wherein

the I/O control step includes, when received data is stored into the send FIFO, storing the received data after outputting the previously 5 received data.

22. The packet transfer method according to claim

20, wherein

the I/O control step includes forcing the 10 minimum unit of data to stay as one unit of data in the send FIFO.

23. A device interface apparatus having a physical layer, a link layer, a transport layer and an 15 application layer, for transferring commands and data in packet format by serial transmission between a device and a host, the interface apparatus comprising:

a packet control condition setting unit when 20 the command received from the host is decoded to start the packet transfer, setting a type of a control function executed after start of the packet transfer and the number of packets to be received or transmitted which defines the start or end of 25 the control function; and

a packet control execution circuit unit detecting that the set number of packets has been

reached during packet transfer and terminating or activating the control function.

24. The interface apparatus according to claim 23,
5 wherein

the packet control condition setting unit,
prior to start of the packet transfer, sets the
number of packets for canceling inhibition of a
reception ready response to a command transmission
10 request from the host during packet transfer, and
wherein

the packet control execution circuit unit
activates an inhibition operation of the reception
ready response to the command transmission request
15 from the host at the time of start of the packet
transfer, the packet control execution circuit unit
canceling the inhibition operation when the number
of the transferred packets reaches the set number
of packets.

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25. The interface apparatus according to claim 23,
wherein

the packet control condition setting unit,
prior to start of the packet transfer, sets a power
25 mode after packet transfer and the number of packets
for entering the power mode, and wherein

the packet control execution circuit unit

instructs to enter the power mode when the number of the transferred packets reaches the set number of packets after start of the packet transfer.

5 26. A packet transfer method for a device interface having a physical layer, a link layer, a transport layer and an application layer, the device interface transferring commands and data in packet format by serial transmission between a device and
10 a host, the packet transfer method comprising:

 a packet control condition setting step when the command received from the host is decoded to start the packet transfer, setting into a control register a type of a control function executed after
15 start of the packet transfer and the number of packets to be received or transmitted which defines the start or end of the control function; and

 a packet control execution step detecting that the set number of packets of the control register
20 has been reached during packet transfer and terminating or activating the control function.

27. The packet transfer method according to claim
26, wherein
25 the packet control condition setting step includes, prior to start of the packet transfer, setting the number of packets for canceling

inhibition of a reception ready response to a command transmission request from the host during packet transfer, and wherein

the packet control execution step includes
5 activating an inhibition operation of the reception ready response to the command transmission request from the host at the time of start of the packet transfer, and canceling the inhibition operation when the number of the transferred packets reaches
10 the set number of packets.

28. The interface apparatus according to claim 26, wherein

the packet control condition setting step
15 includes, prior to start of the packet transfer, setting a power mode after packet transfer and the number of packets for entering the power mode, and wherein

the packet control execution circuit step
20 includes instructing to enter the power mode when the number of the transferred packets reaches the set number of packets after start of the packet transfer.

25 29. A device interface apparatus having a physical layer, a link layer, a transport layer and an application layer, for transmitting commands and

data in pack t format by serial transmission between a device and a host, the interface apparatus comprising:

a packet control condition setting unit when
5 the command received from the host is decoded to start the packet transfer, setting a type of a control function executed after start of the packet transfer; and

10 a packet control condition monitor unit, posterior to start of the packet transfer, detecting a packet transfer status which determines start or termination of the control function and activating or terminating the control function.

15 30. The interface apparatus according to claim 29, wherein

the packet control condition setting unit, prior to start of the packet transfer, sets inhibition of a reception ready response to a 20 command transmission request from the host during packet transfer, and wherein

the packet control condition monitor unit activates an inhibition operation of the reception ready response to the command transmission request 25 from the host at the time of start of the packet transfer, the packet control condition monitor unit canceling th inhibition operation when the numb r

of the transferred packets reaches a predetermined number of packets.

31. The interface apparatus according to claim 29,
5 wherein

the packet control condition setting unit,
prior to start of the packet transfer, sets a power
mode after packet transfer, and wherein

the packet control condition monitor unit
10 instructs to enter the power mode when the number
of the transferred packets reaches a predetermined
number of packets after start of the packet
transfer.

15 32. A packet transfer method for a device interface
apparatus having a physical layer, a link layer,
a transport layer and an application layer, the
device interface transferring commands and data in
packet format by serial transmission between a
20 device and a host, the packet transfer method
comprising:

a packet control condition setting step when
the command received from the host is decoded to
start the packet transfer, setting a type of a
25 control function executed after start of the packet
transfer; and

a packet control condition monitor step,

posterior to start of the packet transfer,
detecting a packet transfer status which determines
start or termination of the control function and
activating or terminating the control function.

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33. The packet transfer method according to claim
32, wherein

the packet control condition setting step
includes, prior to start of the packet transfer,
10 setting inhibition of a reception ready response
to a command transmission request from the host
during packet transfer, and wherein

the packet control condition monitor step
includes activating an inhibition operation of the
15 reception ready response to the command
transmission request from the host at the time of
start of the packet transfer, and canceling the
inhibition operation when the number of the
transferred packets reaches a predetermined number
20 of packets.

34. The packet transfer method according to claim
32, wherein

the packet control condition setting step,
25 prior to start of the packet transfer, setting a
power mode after packet transfer, and wherein
the packet control condition monitor step

includes instructing to enter the power mode when the number of the transferred packets reaches a predetermined number of packets after start of the packet transfer.